

natural; the hardy genera are never associated with the more tropical Eocene floras, and the sub-tropical genera did not range farther north than the present temperate latitudes, nor extend into the later Miocenes. Hardy species occupied these latitudes in the old temperate Eocene times, retreated as the temperature increased, and re-descended from the north as it again decreased, reaching finally as far south as North Italy. The habits and even the species of the genera have not materially altered since the Tertiaries commenced, and they appear to furnish comparatively safe data for physiological inquiries. The most remarkable fact taught by them, a fact beyond all question, is that types now distinctive of widely separated botanical regions actually lived side by side together in Western Europe in the Eocene age.

As the true nature of the various Eocene and Miocene floras becomes unfolded, thanks principally to the able work of Saporta, the fluctuations in temperature that Europe and America have experienced will be measurable and their ebb and flow calculable, with some approximation to certainty. The sensational extremes implied by the over-positive determination of fragments that no human being could determine with certainty, will then, it is to be hoped, be once and for ever discredited.

THE STORAGE OF ELECTRIC CURRENTS

PRACTICAL electricians seem to have made up their minds that a system for the distribution of electricity for the purposes of electric lighting or of driving electric motors will be incomplete unless it comprises a means of storage of the currents to provide against the risk of any temporary derangement or inconstancy in the generating apparatus. An accumulator of currents would in fact render the same service in an electrical system as do gasometers in systems for distributing gas, or the hydraulic accumulators in a system of hydraulic machinery.

At the present time much attention is directed to such accumulators, or, as they have been hitherto called, secondary batteries.

The principle of the secondary battery dates back to the very early days of Voltaic electricity, when in 1801, one year after Volta's "pile" had made its appearance, Gautherot, a French *savant*, observed that wires of platinum or of silver which had served as electrodes for the decomposition of water containing a little salt or sal ammoniac acquired the property of giving a brief current after being detached from the pile. This phenomenon, familiar to every electrician under the name of "polarisation of the electrodes," was observed again by Ritter of Jena, in 1803, with electrodes of gold wire; and the observation immediately led him to devise a battery from which these secondary currents could be readily obtained, and which constituted the first of all secondary batteries. He tried many different arrangements, using various metals—platinum, silver, iron, &c., but with lead he obtained no result. He attributed this secondary action to a soaking or accumulating of the two opposite kinds of electricity into the surfaces of the plates or into the intervening liquid. The true explanation was given by Volta and Marianini, and later by Becquerel, when they showed that the action arose from the deposits of oxygen and hydrogen, or of acid and of base upon the two electrodes, whose surfaces thus became chemically changed and capable of acting towards one another like the zinc and copper plates of an ordinary battery. Grove, in 1843, brought the matter to a decisive proof by constructing his curious gas battery, in which the positive and negative poles were both platinum plates, the one surrounded by oxygen gas, the other by hydrogen. Ritter's failure to obtain any effect from electrodes of lead arose from his employment of solutions of chlorides as the liquid, the chloride of lead which resulted on the passing of the current being a non-conductor, which at

once stopped the current. M. Gaston Planté, who, in 1859, took up the study of the subject, found, after experimenting with many metals, that electrodes of lead, when immersed in dilute sulphuric acid, gave rise to very marked polarisation-effects; for after passing through lead electrodes the current from two Bunsen's cells, the

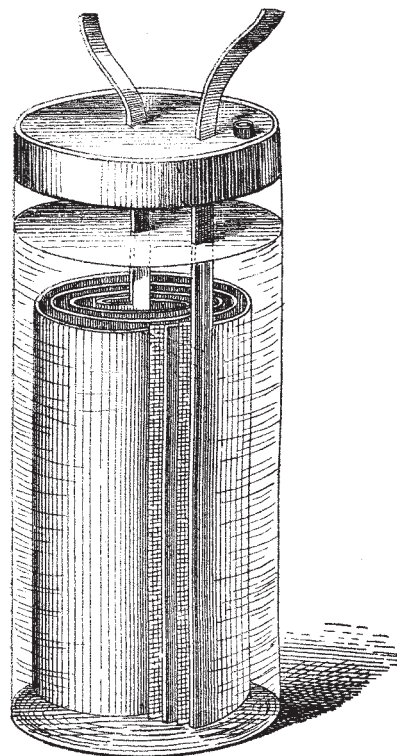


Fig 1.

This figure represents two sheets of lead, separated by two sheets of canvas rolled up together and placed in a glass jar containing water, two strips of sheet-lead protruding through the closed top of the jar.

secondary currents were extremely strong and of considerable duration. He therefore constructed large secondary batteries, using for this purpose two sheets of lead immersed in dilute acid. In order to reduce the internal resistance by bringing the opposed surfaces as nearly as possible together the two sheets were of large size and

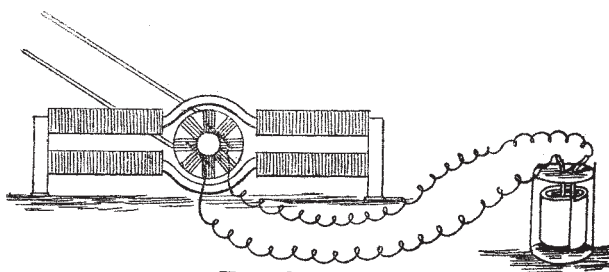


Fig 2

were rolled together in a spiral form, being kept from touching by the interposition of sheets of coarse canvas, or in later forms by means of bands of india-rubber. The general form of a single cell of Planté's secondary battery is shown in Fig. 1. Such cells weighed over twenty pounds, and when properly prepared had an electromotive

force $2\frac{1}{2}$ times that of a Daniell's cell; their internal resistance was also very small, being from one-eighth to one-twentieth of an ohm. These cells improved with use; the liberated gases attacking the surface of the lead electrodes, so that they gradually became of a spongy texture, while the surface of the plate at which oxygen was liberated became covered with a film of brown peroxide of lead. When both electrodes were thus "formed" by charging the cell at intervals of a few days in opposite directions, the Planté cell became a veritable accumulator

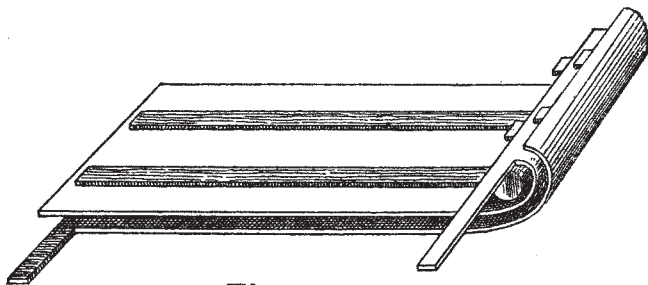


Fig 3

Represents two sheets of lead, separated by strips of thick felt, prepared for rolling together round a roller.

of electric currents, and was able to store up from a comparatively feeble source a supply which could yield vastly stronger effects for a short time. In fact the secondary battery became in Planté's hands a kind of Leyden-jar for storing currents of electricity; the essential point of difference between the two being that while the Leyden-jar accumulates a *charge*, and can be charged or discharged in an instant—or in other words possesses only an "instantaneous capacity"—the secondary battery accumulates currents which may flow into it for many hours, and which may take also a considerable time for their discharge, its "continuous capacity" being very great as compared with its instantaneous capacity. The currents stored up in the secondary battery are however not stored up as accumulations of electricity. They are stored up in the form of chemical work done in the cell, this chemical work being capable of being retransformed at will into the energy of electric currents. When the charging current from an independent battery or from a dynamo-electric machine (see Fig. 2) is passed through a Planté cell, the electrode by which the current enters becomes more highly peroxidised than before, while a corresponding amount of deoxidisation takes place at the electrode by which the current leaves the cell. When the cell thus charged is used as a battery it gives back a current which flows *out* from the electrode by which it formerly flowed *in*; passing through the cell from the deoxidised to the peroxidised electrode, until they are both reduced to a state of chemical similarity. If the cell is joined to the dynamo-machine which charged it, in order to drive it round as an electro-magnetic engine or motor, it will cause it to rotate in the *same* direction as that in which it was driven when used as a generator; the principle of reversibility applying both to the cell and to the machine.

Several forms of secondary battery adapted for storage of currents have been suggested in recent years. In Philadelphia Professors Houston and E. Thomson have tried a modification of the Daniell's cell, in which sulphate of zinc was electrolysed between electrodes of copper, the metallic zinc so deposited afterwards serving as the negative pole of the cell. Another suggestion, due to M. d'Arsonval, was to use an electrode of lead along with one of zinc, dipping into a solution of sulphate of zinc. The charging currents deposited metallic zinc upon the latter and liberated oxygen at the former, which, as in the Planté cell, became coated with spongy peroxide of lead. As this latter is not a very good conductor M. d'Arsonval further proposed to increase the effective surface by laying

the sheet of lead horizontal and covering it with leaden shot, which should also become peroxidised.

The latest form of secondary battery is that of M. Camille Faure, described in NATURE, vol. xxiv. p. 68, of which there has been so much talk in the semi-scientific press, and which is now being made the central point of a great financial "operation" in Paris. There can be no doubt that this instrument, though the accounts of its performances have been grossly exaggerated, is an improvement upon that of Planté, of which it is a slight modification. The labour and difficulty of "forming" the Planté cell, that is to say of charging and recharging it until a sufficient film of peroxide of lead should be produced, led M. Faure to try the effect of coating the lead plates at first with a film of *red lead* or minium, a lower oxide than the dark brown peroxide. The two sheets, after having been covered with minium, are rolled together precisely as in the Planté cells, as shown in Fig. 3, a sheet of felt being interposed to prevent internal contact. It was stated by M. Reynier that the capacity of such cells was forty times that of the Planté cell; but four times would have been nearer the mark if cells of equal size were compared. M. Faure's cells are made of large size and weigh 75 kilogrammes, or nearly 200 lbs. It is stated that one such cell would store a sufficient amount of current as to be able afterwards

to yield in an hour an amount of work equal to one horse-power. Confirmatory observations are yet needed. Meantime let us just remind the enthusiast who brought over to England the "million foot-pounds" of energy stored up in a Faure cell, that he would have imported a dozen times as much stored energy if he had brought over instead a lump of coal of the same weight.

The uses for such secondary batteries may be of three kinds:—1. They may serve as portable supplies of electricity to be left and called for to recharge when exhausted. 2. They may serve to accumulate supplies of electricity from dynamo-electric machines, and store them until required for furnishing electric light or motive power on a small scale. 3. They may serve as equalisers of electric currents in a system in which the supply is liable to fluctuations. Suppose, for example, a dynamo-electric machine is employed to produce electric light. Any least thing which alters the speed of the machine, even for an instant, makes the light flicker and change in intensity; while the breakage of the engine-strap would at once cause total darkness. But if a secondary battery of suitable dimensions and power were inserted across the circuit between the dynamo-machine and the lamp, the inequalities of the current would be greatly modified. When the light was not in use the battery would store up the current. If the engine failed the battery would at once put forth its power. It is probably in this direction that the secondary battery will find no unimportant field of usefulness.

A SINGULAR CASE OF SHIPWRECK

THE wreck of the Danish mail steamer *Phoenix*, which took place off the west coast of Iceland on January 29, was attended by rather unusual circumstances deserving of note. The vessel (about 450 tons burden) sailed with cargo and the mails from Copenhagen for Leith, the Farøe Islands, and Iceland, about the middle of January.

Nothing particular occurred until after leaving the Farøes, when she ran into a severe gale, which rapidly increased to a perfect hurricane, while at the same time the temperature fell to about 50° F. of frost (— 18° F.). Such cold is not extraordinary in these latitudes in winter, but fortunately it is seldom associated with very high winds. Under the circumstances in which the *Phoenix* was placed every sea that she shipped froze, and the deck soon became covered with a foot or two of solid ice.